ENHANCED HEAT TRANFER IN SOLARWATER HEATER (WITH PARABOLIC COLLECTOR) USING PARTIALLY REFLECTIVE GLASS

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1. Abstract

Solar energy collectors are special kind of heat exchangers that convert the solar irradiation into internal energy of the flowing fluid. It is the major component of any solar system. There are basically two types of solar collectors: non-concentrating (or stationary) and concentrating. The concentrating type collectors require tracking mechanism for better performance. Solar water heaters with parabolic collectors are very common type. Line focusing type of collection of radiation energy is adopted in parabolic trough collectors. In this paper an attempt is made to incorporate partially reflective glass with the parabolic collector. Partially reflective glass will allow 50% of the radiation to pass through and the remaining 50% of radiation will be reflected back. This reflected radiation along with incoming radiation is from the source is collimated to form highly intense radiation. This high energy radiation, if allowed to focus on the flowing fluid will result in high temperature output.

2. Introduction

Nowadays, most(80%) of worlds energy demand is met from fossil fuels, massive exploitation of fossil fuels leads to a real threat to the environment, through global warming and acidification of the water cycle. The distribution of fossil fuels around the world is equally uneven. Middle East possesses more than half of the known oil reserves. This fact leads to economical instability around the world, which affects the whole geopolitical system. The present system as it is cannot be maintained for more than two generations. The impact it has on the environment as well to the humans cannot be disputed. So it is mandatory to switch to renewable resources.

Renewable energy technology produces marketable energy by converting natural phenomena into useful form of energy these technologies use the sun's energy and its direct and indirect effects on the earth (solar radiation, wind falling water and various plants, i.e. biomass), gravitational forces (tides), and the heat of the earth's core (geothermal) as the recourses from which energy is produced . These resources have massive energy potential, however, they are generally diffused and not fully accessible, most of them are intermittent, and have distinct regional variability's. These characteristics give rise to difficult, but solvable, technical and economical challenges.

Nowadays, improving the efficiency of collection and conversion, lowering the initial and maintenance cost, and increasing the reliability of and applicability make significant progress. Energy conversion system that is based on renewable energy technologies appeared to be cost effective compared to the projected high cost of oil. Furthermore, renewable energy system can have a beneficial impact on the environmental, economic and political issues of the world.

At the end of 2001 the total installed capacity of renewable energy system was equivalent to 9% of the total electricity generation. By applying a renewable energy intensive scenario the global consumption of renewable sources by 2050 would reach 318 joules.

3. Solar Collectors

Solar energy collectors are special kinds of heat exchangers that transform solar radiation energy to internal energy of the transport medium. The major component of any solar system is the solar collector. This is a device that absorbs the incoming solar radiation, converts it into heat, and transfers the heat to a fluid (usually air, water, or oil) flowing through the collector. The solar energy Collected is carried from the circulating fluid either directly to the hot water or space conditioning equipment or to a thermal energy storage tank, from which it can be drawn for use at night or on cloudy days.

There are basically two types of solar collectors: non-concentrating or stationary and concentrating. A non-concentrating collector has the same for intercepting and absorbing solar radiation, whereas a sun-tracking concentrating solar collector usually has concave reflecting surfaces to intercept and focus the sun's beam radiation to a smaller receiving area, thereby increasing the radiation flux. Concentrating collectors are suitable for high-temperature applications. Solar collectors can also be distinguished by the type of heat transfer liquid used (water, non-freezing liquid, air, or heat transfer oil) and whether they are covered or uncovered. When solar radiation passes through a transparent cover and impinges on the blackened absorber surface of high absorptive, a large portion of this energy is absorbed by the plate and transferred to the transport medium in the fluid tubes, to be carried away for storage or use. The underside of the absorber plate and the two sides are well insulated to reduce the conduction loss the liquid tubes can be welded the absorbing plate or they can be an integral part of the plate. The liquid tubes are connected in both the ends by large-diameter header tubes.

3.1. Using reflective surfaces

In this type the collector consist of mirror in order to get a good reflection. Schematic diagram shows the collector with reflecting surfaces. Here an attempt is made to impart the partially reflecting mirror in between the collector and receiver, the purpose of partially reflecting mirror is to split the light into two halves. The detailed explanation is given below.

4. Physics Behind Partially Reflective Glass

In this paper an attempt is made to impart the partially reflecting glass to improve the efficiency of the System. A partially reflected glass is also known as semi silvered glass which allows the light partially into the target and remaining into the source. It is used in lasers in order to achieve the high coherent and intense source of light. Initially small quantity of photon is generated by optical pumping and the photons lies in between the partially and fully reflected mirror, and then the generated photon is allowed to strike the partially reflective mirror.50% of photons passed to the required target, and the remaining 50% enters into the source. By multiple reflections the intensity of the beam gets increased. In this solar heater, a partially reflected glass is placed in between the collector and receiver, when the incident sunlight fall on the collector it is passed to the partially reflective mirror. it send 50% of radiation to the receiver remaining 50% return back to the collector, but the collector receiving the radiation continuously, thus the intensity of the radiation get increased, thus very huge amount of heat is generated.

5. PRINCIPLE OF SUPER POSITION

When two waves travel in a medium simultaneously in such a way that each wave represents its separate motion, then the resultant displacement at any point at any time is equal to the vector sum of the individual.

It may be either constructive interference or destructive interference, it is shown in the below figure (a&b).

As per the above consideration the incident light is allowed to enter into the partially reflecting glass ,only 50% of radiation is allowed to strike the copper tube remaining 50% of radiation is return back to the collector, in the collector the incident radiation also strikes it imposes with each other resulting in either rise or fall in amplitude of the wave, when there is a rise in amplitude there is a rise in energy level, because energy is proportional to the square of amplitude, if it results in destructive interference the destructive energy is converted into heat however our ultimate aim is to increase the heat this both way is used to increase the efficiency of the system

6. Tables, figures, equations and lists

6.1. Tables

Tab. 1: Average reading for one week (during march 2010) without partially reflecting glass

Time	Amb tem	Inlet Temp	Outlet Temp	Temp Rise
9.00	33	31	31	0
10.00	33	30	32	2
11.00	33	30	34	4
12.00	34	32	38.5	6.5
13.00	34	33	41	8
14.00	34	33	41	8
15.00	34	33	40	7
16.00	34	34	40	6
17.00	28	33	37	4

Tab. 2: Average reading for one week (during march 2010) with partially reflecting glass

Time	Amb Tem	Inlet Temp	Outlet Temp	Temp Rise
10.00	33	30	31	1
10.03	33	30	34	4
11.00	33	30	40	10
12.00	26.5	29	43	14
13.00	25	29	44	15
14.00	26	30	50.5	20.5
15.00	26	32	43	11
16.00	26	32	41	9
17.00	25	32	40	8

6.2. Figures

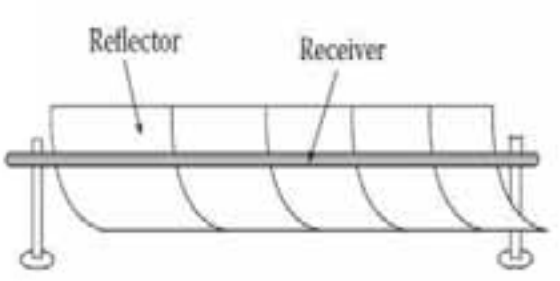

Fig. 1: Parabolic collector with reflective mirror

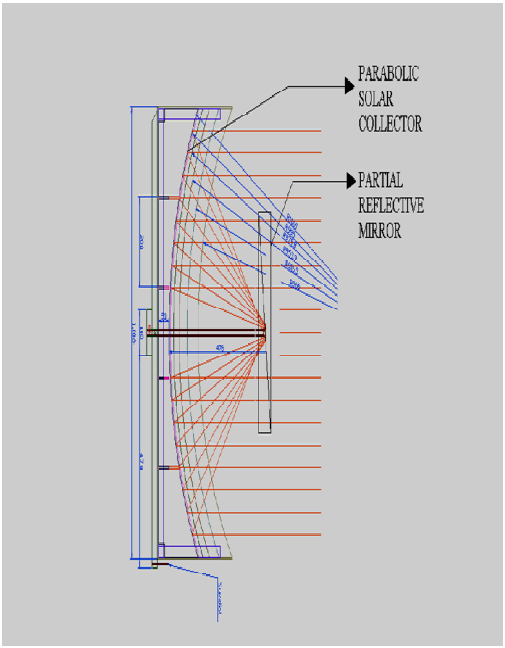

Fig. 2: Schematic diagram of collector along with partially reflecting mirror

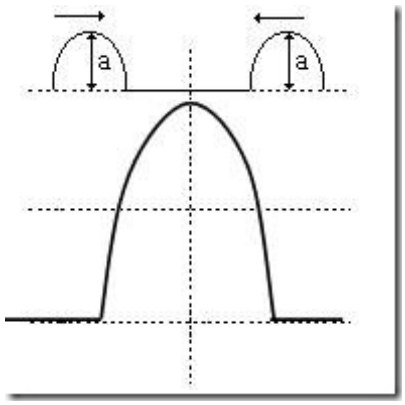

Fig. 3: Constructive interference

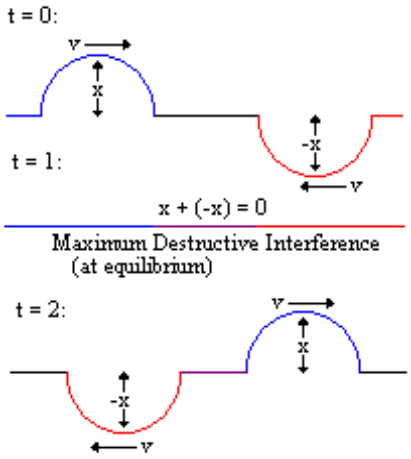

Fig. 4: Destructive interference

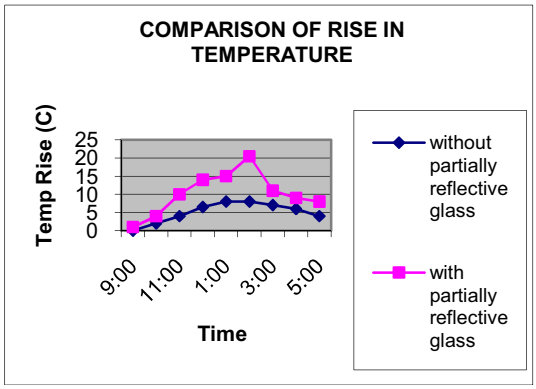

Fig. 5: Comparison of rise in temperature

7. Conclusion

In this paper an attempt is made to introduce the concept of laser (coherent beam) for the application in solar water heater. The experiments conducted shows there is scope to incorporate partially reflective glass in the path of the solar radiation and this also results in the increased outlet water temperature.

8. References

Alastair I.M.Rae-quantum physics illusion or reality, Cambridge university press.

Barry L.Butler, golden, colo- light weight diaphragm mirror module system for solar collectors, US PATENT, 1985.

David K. Fork, Palo Alto, Calif-laser beam conditioner using partially reflective mirrors, US PATENT, Jan, 1999.

G.D Rai- non conventional energy sources-khanna publication-2007.

P.L.knight & A. miller- measuring the quantum state of light, Cambridge studies in modern optics.

Stu campell-build your own solar water heater, garden way publishing charlotte, Vermont 05445